The Collaborative Science, Technology, and Applied Research (CSTAR) Program

Improving Analyses, Numerical Models, and Situational Awareness of High-Impact Severe Convective and Mixed-Phase Precipitation Events in Complex Terrain

University: University at Albany

Name of University Researcher Preparing Report: Kristen L. Corbosiero

NWS/AFWA/Navy Office: National Weather Service, Albany, New York

Name of NWS/AFWA/Navy Researcher Preparing Report: Michael Evans

National Oceanic and Atmospheric Administration (NOAA) Award #: NA19NWS4680006

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1. SUMMARY OF STUDENT RESEARCH ACTIVITIES

a) Near-freezing winter precipitation type in complex terrain

Graduate student: None
PI and co-PIs: Justin Minder, Nick Bassill, Robert Fovell, Andrea Lang
NWS focal points: Michael Evans (ALY) and Frank Nocera (BOX)

Research summary:

During summer 2021, Mr. Seymour completed his research, prepared his M.S. thesis, and presented his research at a departmental seminar. The thesis, *Predictability Issues Associated with Near-freezing Precipitation Type in Complex Terrain* was accepted by the university and published. Mr. Seymour received his M.S. degree and has begun working as forecaster at a private company, leveraging the skills he learned during through this CSTAR project. Mr. Seymour and co-PI Minder will work to prepare a journal article for submission, based in the results of the thesis.

Results from this research were presented at the National Weather Association Annual Meeting and the New York State Mesonet Annual Science Symposium.

Co-PI Minder has begun efforts to recruit a new student to work on this project, starting in Fall 2022. Future research will likely focus on using our existing case study result to inform a study of operational high-resolution model skill at forecasting winter precipitation type. It may also leverage data to be collected this upcoming winter as part of the NSF-funded Winter Precipitation Type Research Multi-scale Experiment (WINTRE-MIX), led by co-PI Minder

b) Severe convection in complex terrain and across severe-weather environments

Graduate student: Rachel Eldridge
PIs and co-PIs: Brian Tang and Robert Fovell
NWS focal points: Thomas Wasula (ALY) and Joe Dellicarpini (BOX)

Research summary:

Graduate student Brennan Stutsrim, co-PI Brian Tang, and co-PI Robert Fovell completed work on identifying environmental characteristics that are conducive to back-building convection and the attendant risk of excessive rainfall in the New York Capital Region. Additional analysis was carried out with the goal of providing forecasters with synoptic setups and threshold values of meteorological variables that are useful for forecasting back-building convection and excessive rainfall. Prior six-month reports describe the case selection, data sources, and analysis tools.

Using a decision-tree framework, cases were divided into correctly forecasted back-building cases and falsely forecasted back-building cases (false positives). Figure 1 shows Hudson Valley area-averaged soundings for these correctly forecasted cases and false positive cases. While both sets of cases had high CAPE (> 2000 J kg^{-1}), associated with a warm, humid airmass, there were notable differences in the vertical wind profile. False positive cases had stronger southwesterly winds through most of the troposphere. Thus, back-building cases featured weaker mean flow that contributed to slower mesoscale convective system propagation, particularly where there is channeled, southerly flow up the Hudson Valley. Additionally, the weaker vertical wind shear resulted in a predominate multi-cellular mode, rather than more of a tendency for upscale growth and more rapid movement of convection off to the east. The composite sounding of back-building cases serves as a useful reference to compare against forecast soundings, particularly in the Hudson Valley, to assess whether the CAPE and vertical wind profile are consistent with a risk of back-building convection and excessive rainfall.

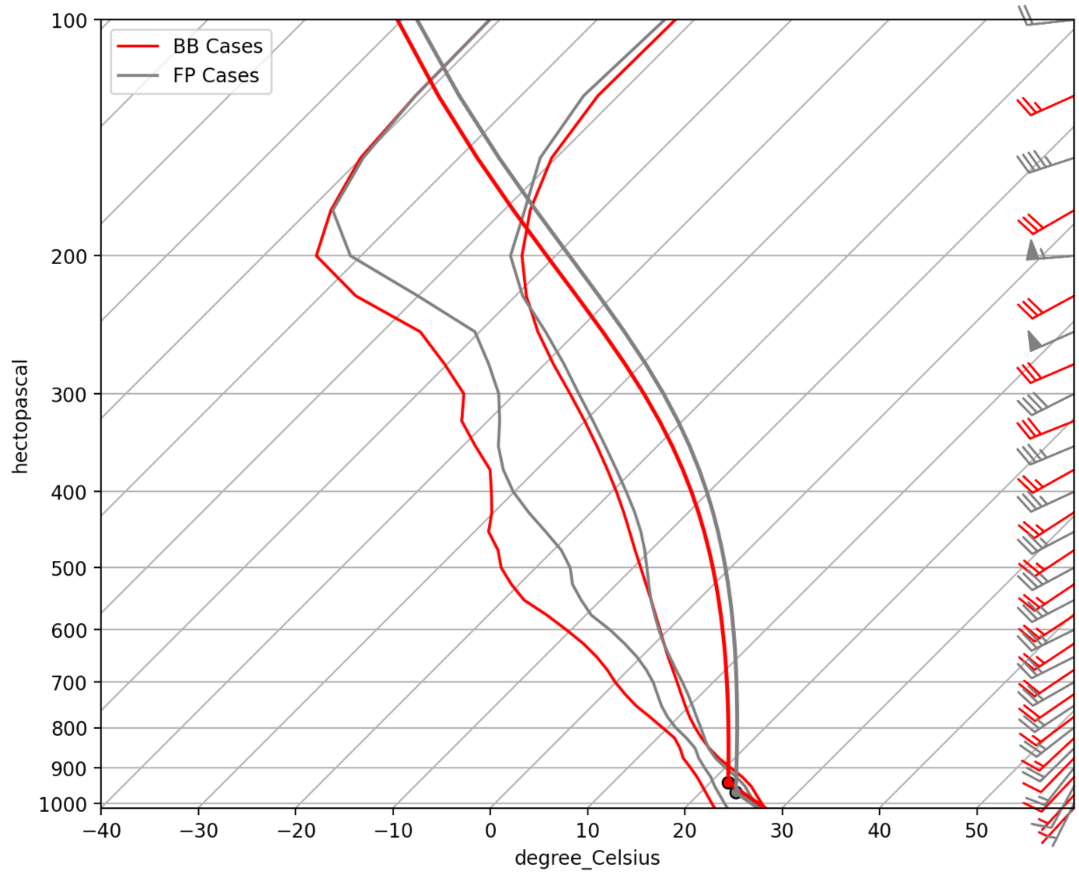

Figure 1: *Composite, area-averaged soundings of correctly forecasted back-building (BB) cases (red) and falsely forecasted back-building (FP) cases (gray). On the skew-T, log-p diagram, thick profile is the temperature, thin profile is the dewpoint, and barbs show the vertical profile of the wind. 1800 UTC HRRR analyses are used to compute the area-averaged soundings in the Hudson Valley region.*

Brennan finished and presented his Master's thesis in August 2021. He is now employed in the Center of Excellence in Weather and Climate Analytics.

Luke LeBel, co-PI Brian Tang, and Ross Lazear published a manuscript in *Weather and Forecasting* examining terrain effects on the Mechanicville, NY tornado event of 31 May 1998. The publication appeared online in October 2021 and is in the December 2021 print edition. Please see our previous six-month reports for the main findings of the study.

Rachel Eldridge, our new graduate student, started initial work investigating how the High-Resolution Rapid Refresh (HRRR) model performed during recent severe weather events in the Capital Region. The primary goal is to assess biases in the HRRR pre-convective environment that could contribute to deficiencies in the forecasted convective evolution of the events, and whether these biases are associated with the underlying complex terrain.

HRRR model output was compared to New York State Mesonet (NYSM) observation for three events: 31 May 2017, 15 May 2018, and 15 May 2020. These three cases were chosen from the NWS Albany past significant weather events webpage. Rachel plans to analyze these three events during the period when they passed over the Mohawk and Hudson valleys.

Figure 2 shows a comparison of HRRR wind and 2-m temperature forecasts with NYSM observations for the 15 May 2020 event at Herkimer, NY. Convection moved through Herkimer around 2100 UTC on this day. Compared to observations, the HRRR tends to shift the winds to more of a westerly direction too early in the day. Additionally, forecast 2-m temperatures tend to be too warm in the morning hours and then slightly too cold during the afternoon hours leading up the convection. Additional sites along the path of the convection will be compared to assess where common biases emerge, reasons for these biases, along with the effects of these biases on the pre-convective environment.

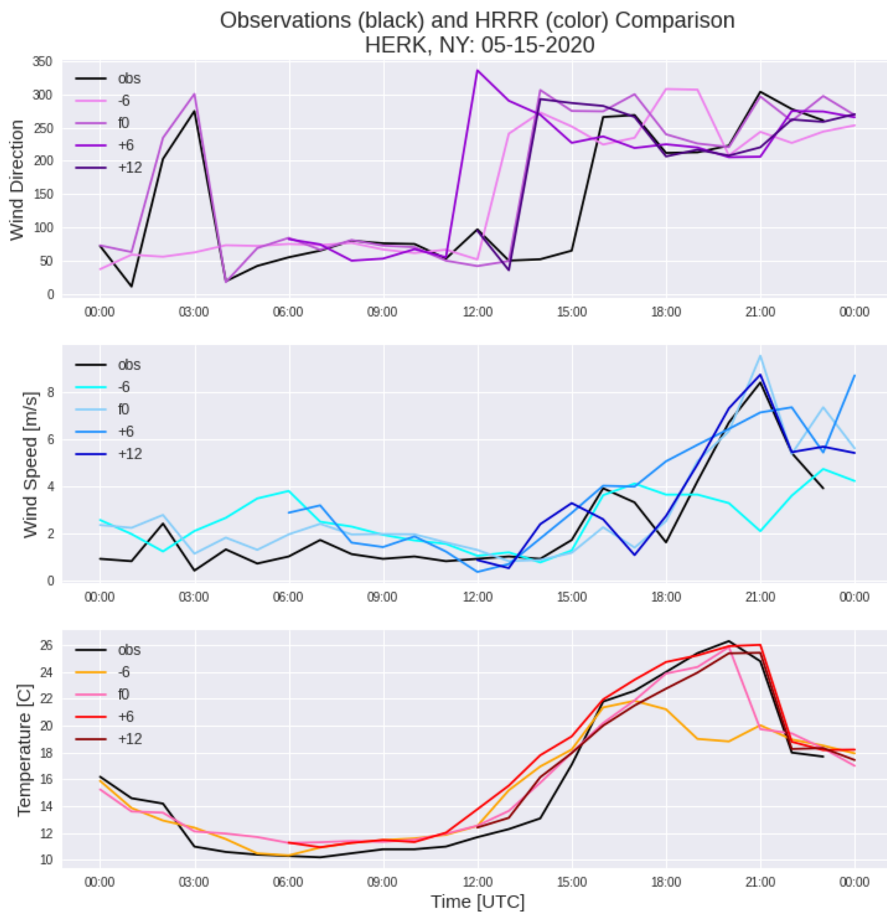

Figure 2: *Time series comparison between four HRRR model runs, initialized at 18 UTC 14 May 2020, 00 UTC 15 May 2021, 06 UTC 15 May 2021, and 12 UTC 15 May 2021, and NYSM observations at Herkimer, NY. Top panel is the wind direction, middle panel is the wind speed, and bottom panel is the 2-m temperature.*

NWS Interactions:

Brennan presented his Master's research to the department and NWS forecasters who were able to join. He also presented his findings at the 22nd Northeast Regional Operational Workshop. Both events were held virtually. NWS forecasters had a chance to learn about the research and ask Brennan questions about his work and its operational relevance. Brennan is currently working on creating a quick reference page of his findings, such as the information shown in Figure 1, for the Albany CSTAR Virtual Lab.

c) Data fusion applications to assess forecast uncertainty and improve analyses

Graduate student: Brian Filipiak

PI and co-PIs: Kristen Corbosiero, Nick Bassill, Andrea Lang, and Ross Lazear

NWS focal points: Christina Speciale (ALY) and Neil Stuart (ALY)

Research summary:

During this reporting period, Brian Filipiak made significant progress on the development of his random forest algorithm as well as created an operational product to display the algorithm output in live time. The previous CoCoRaHS cases were modified to no longer include wintry mix and mixed precipitation classification due to the finding that these terms tended to be more generally used, which caused confusion within the random forest. In replacement, snow and rain cases were identified using the CoCoRaHS comments section in a similar manner to the originally identified cases. This process was done to give us a similar number of cases as the freezing rain and sleet. The total number of cases identified was about 3000 with around 750 cases for each type of precipitation. These cases were then matched with the appropriate data sources.

Previous CoCoRaHS cases were matched with hourly and 5-min NYS Mesonet data. Additional data was identified and incorporated into the CoCoRaHS cases along with upper air soundings from NWS offices in Buffalo, Albany, and Upton, NY and from Canadian site Maniwaki, Quebec. BUFKIT data was incorporated from the NAMNEST 4-km model; this provided 33 sites distributed throughout the state that give vertical profiles to be used in a forecasting framework. All CoCoRaHS cases were updated to include all these data sources which created two main data sets for the random forest: one for nowcasting (NYS Mesonet and upper air soundings) and one for forecasting (NAMNEST).

Extensive work was done in testing the random forest using the entire CoCoRaHS database. Evaluation methods were changed from just overall accuracy score to incorporate precision, recall, and a composite F1 score (Figure 3), which added information gave more insight into how well the model was preforming. In addition to evaluation methods changing, the random forest was also slightly altered. The training and testing split were kept the same at 75/25, but the number of trees was changed to 650 and some additional settings were updated, including stratifying the training and testing data so that each data set had the same proportion of each type of precipitation. The process for updating the number of trees and the settings was accomplished through hyper tuning the parameters, which was initially done through a random search of different sets of conditions and then a grid search of a narrower range of conditions; all processing was done with 10-fold cross validation.

$$Accuracy = \frac{True\ Positive + True\ Negative}{Total\ Cases}$$

$$Precision = \frac{True\ Positive}{True\ Positive + False\ Positive}$$

$$Recall = \frac{True\ Positive}{True\ Positive + True\ Negative}$$

$$F1 = 2 * \frac{Precision * Recall}{Precision + Recall}$$

Figure 3: *Equations for random forest evaluation metrics using a confusion matrix.*

Initial testing showed that the NYS Mesonet and upper air dataset was about 80% accurate with F1 scores varying across precipitation types. As expected, rain and snow F1 scores were close to and above 90% while freezing rain and sleet F1 scores were closer to 65% and 55%. For the NAMNEST, the resulting accuracy score was lower, around 75%; the F1 scores were similar to the NYS Mesonet and upper air, but lower overall. In particular, the freezing rain and sleet scores were 60% and 52% respectively, which caused a discussion about how to improve the model sounding data; the clearest possible way to improve was by adding in additional, more derived variables into the data set. To determine what these variables would be, additional reading was done regarding precipitation type discriminating products and precipitation type studies as well as discussion with the NWS Focal Points to identify what were key variables to include.

The updated variables improved the NAMNEST testing results dramatically. The overall accuracy score went up 5% to 80%; there were increases in the F1 scores across the precipitation types, but the freezing rain and sleet scores increased the most (Figure 4). In the NYS Mesonet and upper air data set, we wanted to see if the upgraded variables along with the additional of another sounding site (Maniwaki, Quebec) could improve that data set as well. The results of showed a slight decrease in accuracy and lower mixed precipitation F1 scores. This finding presented an interesting result even though the overall scores decreased; it indicated that the different vertical profiles (balloons versus model) required different combinations and types of variables to have the most correct and accurate identifications. This realization is a key result about using machine learning techniques: the quality of the reports and the consistency and types of data put into the algorithm can have a significant impact on the final product and results.

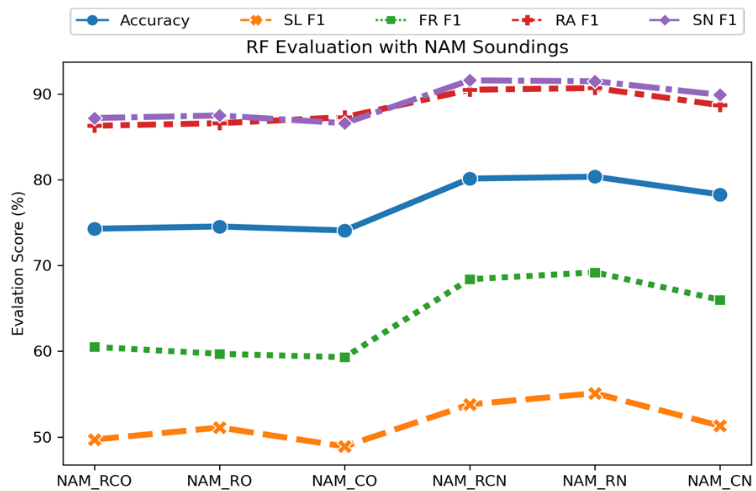

Figure 4: *NAMNEST random forest testing results without and with new derived variables. Notation: NAM_RCO: NAM Raw and Calculated Original, NAM_RO: NAM Raw Original, NAM_CO: NAM Calculated Original, NAM_RCN: NAM Raw and Calculated New, NAM_RN: NAM Raw New, NAM_CN:*

One of the major accomplishments during this period was the operational website developed by Brian. The random forest output of precipitation type probabilities and the most important variables used in making those determinations, both averaged over 50 runs of the random forest, were made into figures, and housed on a website developed by Brian. The website can be found at http://www.atmos.albany.edu/student/filipiak/op/.

There are six primary products produced for each of the nowcasting (NYS Mesonet and upper air data) and forecasting (NAMNEST) data set: probabilities for rain, snow, freezing rain, sleet, mixed precipitation, and dominant precipitation type. The mixed precipitation product shows the sum of the probabilities for freezing rain and sleet. The dominant precipitation type product displays which precipitation type would be dominant at any given location; this product is color coded for precipitation type. All products contain the probabilities as well as the current radar imagery from MRMS or composite reflectivity from the model. The model products show up as a slideshow that allows the viewer to see the evolution over the forecast period (Figure 5). In addition to the actual products, there is a data and methods section for people to learn more about the project and the method behind the algorithm; there is also a training tab that will be populated with training videos and figures as well as any updates to the website. This website has been made publicly available and has been shared with the relevant entities.

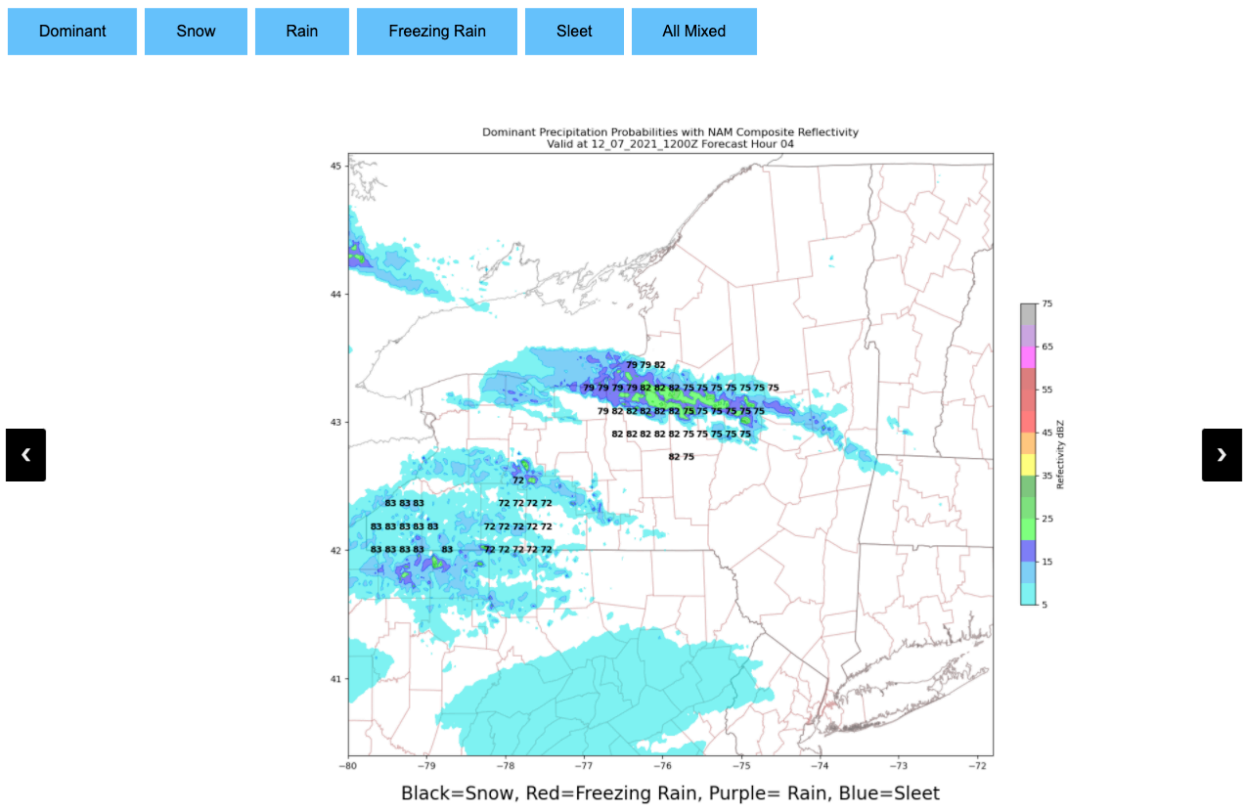

Figure 5: *Screenshot of NAMNEST forecast from the operational website.*

There are several future work components to this project. One of these is to perform a version of a climatological analysis on the variables included in the different data sets. This is an important step because it will allow not only for verification that the data points collected make sense to use as well as allow for visualization of the case distribution. In addition to that, it shows us more information about why some variables are determined to be more important in the decision-making process than others. This information will be invaluable when learning more about the mechanics of the random forest. Another component involving the variables that will be completed is creating composite or typical sounding profiles. This can allow for visual verification that the vertical profiles we are using make sense. The plan is to do this at different percentiles to get a visual evolution across the range our data covers.

Another key component of our future work is to evaluate how our algorithm compares to other deterministic precipitation type methods. Our plan is to create contingency tables with the different methods to directly compare them to our random forest algorithm. We will compare against the NAMNEST precipitation type and Bourgouin Positive and Negative Area method at a minimum. We will be able to calculate statistics like bias, critical success index, false alarm ratio and probability of detection to use for our comparison.

An additional component of our future work will be evaluating our operational product during and after this winter season. Because the current products are being archived, we will be able to evaluate them in more detail after the current winter. Moreover, an NSF field campaign, WINTRE-MIX, is occurring this winter with a focus on mixed precipitation events. This will give not only clear cases and observations to evaluate our method against, but can provide additional cases to incorporate into our algorithm. Most of this evaluation will occur after the main winter season concludes.

NWS Interactions:

During this reporting period, Brian was in regular contact with his NWS Focal Points regarding the Data Fusion project. They met in August to discuss some of the improvements to the random forest algorithm that were made over the summer. In addition to discussing these improvements, Neil, Christina, and Mike all provided additional suggestions regarding some important environmental variables that should be included in the algorithm. They also gave suggestions for additional data sources and data combinations that could be included. At the next meeting in September, the updated random forest results were shared. This meeting included the major improvements in the NAMNEST testing results. Additionally, there were discussions around creating more clarity about what variables are important in deciding between specific types of precipitation. It was also mentioned that a proof of effectiveness type study would be good to show how the random forest tool compares to other products. In November, we held our final meeting during this reporting period, and it was devoted to examining the operational website and making suggestions to product presentation and website design. A wish list of items was also generated to help guide future work on the project as well.

Brian's NWS interactions were not limited to just his Albany focal points. NWS Binghamton was also very interested in the Data Fusion project after seeing Brian's presentation at the Northeast Regional Operational Workshop in November. A website description and the website URL were distributed to staff at that office; initial comments based on the early winter season have been positive to the product's effectiveness. After Brian's presentation at the NOAA's WPC Winter Weather Experiment, NWS Charleston (WV) reached out to him about creating a similar product for their county warning area. Brian has had discussion with them and has provided suggestions about how to proceed with doing a similar project.

2. CSTAR VII PROJECT THESES, PRESENTATIONS, AND PUBLICATIONS

(For a complete list of UAlbany–NWS Albany CSTAR project publications, please see http://www.atmos.albany.edu/facstaff/kristen/CSTAR/CSTAR_CumulativePublications.pdf.)

a) Theses completed

Seymour, M., 2021: Predictability issues associated with near-freezing precipitation type in complex terrain. Master of Science Thesis, Dept. of Atmospheric and Environmental Sciences, University at Albany/SUNY, 179 pp.

Stutsrim, B., 2021: A mechanism for upscale growth of convection in the complex terrain of the Northeast U.S. Master of Science Thesis, Dept. of Atmospheric and Environmental Sciences, University at Albany/SUNY, 111 pp.

b) Presentations

Filipiak, B., K. Corbosiero A. L. Lang, R. A. Lazear, and N. P. Bassill, 2021: Data fusion: A machine learning tool for forecasting winter mixed precipitation events. *First Annual New York State Mesonet Science Symposium,* 29 September, Albany, NY.

Filipiak, B., K. Corbosiero A. L. Lang, R. A. Lazear, and N. P. Bassill, 2021: Data fusion: A machine learning tool for forecasting winter mixed precipitation events. *22nd Annual Northeast Regional Operational Workshop*, 9 November, Albany, NY. (Virtual)

Filipiak, B., K. Corbosiero A. L. Lang, R. A. Lazear, and N. P. Bassill, 2021: Data fusion: A machine learning tool for forecasting winter mixed precipitation events. *Albany Weather Forecasting Office Fall Meeting*, 19 November, Albany, NY. (Virtual)

Lazear, R. A., and M. Evans, 2021: Collaborations between the NWS and the University at Albany before and after our move to the ETEC. *22nd Annual Northeast Regional Operational Workshop*, 9 November, Albany, NY. (Virtual)

Seymour, M., 2021: Initial and boundary condition uncertainty's role in predicting precipitation type in complex terrain. *46th National Weather Association Annual Meeting,* 22 August, Tulsa, OK.

Seymour, M., and J. Minder, 2021: Assessing the effects of initial and lateral boundary conditions on mesoscale predictability of precipitation type over complex terrain. *First Annual New York State Mesonet Science Symposium,* 29 September, Albany, NY.

Stutsrim, B., B. Tang, and R. Fovell, 2021: A mechanism for upscale growth of convection in the complex terrain of the Northeast U.S. *22nd Northeast Regional Operational Workshop*, 10 November. (Virtual)

c) Refereed publications

LeBel, L., B. Tang, and R. Lazear, 2021: Examining terrain effects on an Upstate New York tornado event utilizing a high-resolution model simulation, *Weather and Forecasting*, **36**, 2001–2020.

3. RESEARCH TO OPERATIONS

Updates to the Albany CSTAR Virtual Lab (VLab) community page are ongoing, with traffic to the page monitored using Google Analytics. Agendas and preprints for the Northeast Regional Operational Workshop (NROW) dating back to 2000 continue to be added to the VLab. In collaboration with NWS–ALY, starting with 2021, NROW presentations will also be added to the VLab.

Ross Lazear has met with recent CSTAR M.S. students Matthew Seymour and Brennan Stutsrim along with their NWS focal points to develop operationally relevant quick references of their major research results. Matthew Seymour's research reference focuses on planetary boundary layer and microphysics schemes and their biases in forecasting winter precipitation type in complex terrain. Brennan Stutsrim's work involves a forecasting flow-chart, composite sounding, and phase–space diagram for thunderstorm environments conducive to back-building in river valleys. As has been done with previous CSTAR research, these references will be linked to operations via the AWIPS Interactive Reference (AIR) tool.

4. NWS PERSPECTIVE ON CSTAR VI PROGRESS *(Michael Evans, SOO WFO ALY)*

The collaborative relationship between the NWS Albany forecast office and UAlbany's Department of Atmospheric and Environmental Sciences has remained strong, despite recent challenges associated with COVID-19. The collaboration associated with CSTAR VII continues to be one of the cornerstones of this relationship. From the NWS perspective, work on this and other projects with UAlbany remains critical for maintaining a strong culture of science-based forecasts, warnings, and decision support at the Albany forecast office. The recent move to collocate the NWS with the department in the new ETEC building will strengthen our relationship moving forward.

NWS ALY SOO Mike Evans and UAlbany's Ross Lazear gave a presentation at the Northeast Regional Operational Workshop on plans for our collaborative relationship moving forward. These plans include continued participation in future CSTAR-funded projects.

ALY SOO Mike Evans has developed a study that examines the characteristics of right of track storm winter storms such as the 16–17 December 2020 historic storm. The study was done in collaboration with Tomer Burg and was based on the research that he did in CSTAR VI. Tomer is now a PhD student at the University of Oklahoma. Mike Evans and Boston SOO Joe Dellicarpini (who was an NWS focal point for Tomer's work in CSTAR VI) are developing a presentation for the Eastern Region of the NWS based on Tomer's work and Mike's study. The presentation is scheduled for January 2022.

Regarding Major Project #1, Matt Seymour completed work on this project and gave his Master's thesis defense in July, 2021. NWS Focal Point Mike Evans attended the presentation virtually. There remain many forecast challenges with winter weather events associated with marginal, near freezing temperatures and the impacts of terrain on these types of events. Matt and Mike discussed some of these challenges with Matt toward the beginning of his project. Matt's project focused on identifying and quantifying model biases associated with various configurations of the WRF. His results highlight many of the challenges faced by operational forecasters during these events. For a case study from 23 March 23, Matt highlighted the importance of accurate forecasts of precipitation rate and simulation of terrain-induced factors such as downslope wind flows. His findings imply that forecasters need to be especially concerned about model warm biases in scenarios where models may be under-forecasting precipitation rates associated with meso-scale precipitation bands. In addition, forecasters need to carefully evaluate the accuracy of model depictions of terrain-induced flow patterns, which can adversely affect forecasts of boundary layer temperatures and precipitation type. These findings will help our forecasters to more effectively evaluate model guidance to make better forecasts.

For Major Project #2, Brennan Stutsrim completed his thesis on convection in the Hudson Valley and presented in July. Brennan gave a concise version of his CSTAR research at the 22nd Northeast Regional Operational Workshop on 9 November. Some future work questions included: Do 3-km resolution operational models adequately resolve terrain channeling?, and can NYSM profilers be used to assess cold pool depth and other measures of cold pool strength in real time?

NWS BOX is planning to extend Brennan's work to the Connecticut River Valley in New England to see if similar evolutions are identified. Tom Wasula and Joe Villani hope to work with Brennan to give an Eastern Region webinar on his results in the April–June 2022 time frame. Tom and Joe would each like to show a case study after Brennan's initial work and climatology. After Brennan's presentation to our staff during the spring, Mike noticed that Brennan's findings on the evolution of convective storms as they reach the Hudson Valley has been applied during convective events at NWS ALY. Mike noticed several events during the past warm season when forecasters were discussing Brennan's findings in real time as events evolved. These findings have improved situational awareness of events that may change evolutions quickly upon reaching the Hudson Valley.

Tom Wasula gave a presentation at the 29 September 2021 NYS Mesonet Symposium entitled, "The 24 August 2020 Whitehall, NY Flash Flood". This was another case where back building storms produced high impact weather in the Hudson Valley. In the Whitehall, NY flash flood case, a cooperative observer had 5.85" of rainfall from training/back-building cells in 2–4 hours. It was a 500-year heavy rain event based on the NRCC Extreme Precipitation Analysis. The convective environment was weak- moderate shear with moderate to extreme instability. PWATs were above normal (75–90%) with low Flash Flood Guidance 1, 3, and 6 hours. The village was hit hard with the flooding (four reports) and 11 wind damage reports. Descending KDP columns also contributed to the wet microbursts.

Undergraduate student Ryan Schwimmer did a case study from a severe weather event in August 2021 and included an analysis of the evolution of the convection as it entered the Hudson Valley. The study was done for one academic credit and was supervised by ALY SOO Mike Evans. The plan is to have the student present the study at a case study presentation day for the UAlbany department and NWS ALY at some point during the spring semester.

Finally, for Major Project #3, Brian Filipiak met with NWS Focal Points Neil Stuart, Christina Speciale, and SOO Mike Evans in September to discuss the progress on this project. Discussions included optimum data sets to include in his random forest decision tree algorithms, and ideas for displaying results on his web page. Brian also gave a presentation on his project at our staff meeting in November, and gave a presentation on his work to a wide NWS audience at a virtual seminar associated with NOAA's Weather Prediction Center winter experiment.

This project will aid our operations by providing a useful tool to improve forecasts of mixed precipitation during marginal, near-freezing scenarios. The guidance that Brian is developing is largely probabilistic in nature, as his web page will be displaying probabilities various types of precipitation based on inputs from observational networks along with model guidance. This approach will help our forecasters to continue to think probabilistically when it comes to difficult forecasting challenges. In addition, this project will continue to introduce our forecasters to the benefits of machine learning approaches, which will doubtless be increasingly important in the field of meteorology moving forward.

5. COLLABORATIVE AND ASSOCIATE PROJECTS *(Michael Evans and focal points)*

The eight collaborative projects associated with CSTAR VII are listed below, along with updates on progress from June through November 2021.

1. Improvement of tornado detection and lead time

Team lead: Joe Dellicarpini (BOX) and Christina Speciale (ALY)

NWS ALY Hollings Student Hailey Culwell worked on this project during the summer of 2021. She looked at some of the tornado warning improvement project (TWIP) "nudgers and confidence builders" to see if they can be added to the BOX local radar Warning Guidance. She found that skill improved when TWIP nudgers and confidence builders were added to the methodology. Hailey completed her work on this project in August and gave a presentation on her findings at the Northeast Regional Operational Workshop in November. BOX is planning is to look at TWIP factors more in the next year to see if we can integrate any of the findings.

2. Warm season QPF challenges: identifying when model precipitation, areal coverage, location and maximum amounts will be skillful

Team lead: Justin Arnot (GYX)

Over the past six months, the team was tasked with examining the performance of the HREF and NCAR high resolution ensembles completed their analysis of the ensemble forecast data. Two methodologies were employed to review the ensemble forecasts. One was objective, while the other was semi-subjective. The results of these approaches were compared/contrasted. In addition, the team also developed multiple small case studies of events (2021 Bar Harbor flood event, 2021 Hurricane Elsa) to use in comparing independent cases with the overall research results. Finally, all of the results to date were presented in summary form at the 2021 Northeast Regional Operational Workshop in November.

The team is working to wrap up the project by the spring of 2022. To accomplish this, there are plans to package the final results of the research in two ways: The first is to develop a NWS Eastern Region Technical Attachment. A date of 1 April 2022 has been set to have a draft of this TA to Eastern Region Headquarters. The second is to develop a science sharing presentation to be given to NWS Eastern Region offices in the early spring 2022 (likely March) in anticipation of the 2022 convective season. Once these two activities are complete, the project will be complete.

3. Recent dual-polarization radar techniques to support severe weather operations

Team lead: Mike Jurewicz (CTP)

This work was related to using patterns of dual polarization radar variables to improve tornado warnings. Work is now underway to transition findings from this research into operations. Supplemental placefiles have been added to the GR2 Analysis which allow users to view level 2 radar data in both live, real-time and archived formats. These placefiles allow the user to employ tools which help to visualize and quantify ZDR and KPD separations (i.e., separation vector angles and physical separation distances) in potential tornado warning situations. Mike discussed these developments and showed case studies at NROW in November.

4. Using GLM lightning data in operations for severe weather forecasting and enhanced DSS

Team leads: Jared Klein (LIX) and Mike Jurewicz (CTP)

Jared Klein has moved down to Slidell and the project is on hold.

5. Using GAZPACHO to verify high-resolution model snowfall forecasts from 2017–2019

Team leads: Joe Villani and Mike Evans (ALY)

A follow-up study may be done relating the analysis of the winter events included in this study to forecast errors and storm tracks, to see if there are any characteristic storm tracks associated with various storm tracks, such as Miller A and Miller B tracks. This project may involve a student from UAlbany.

6. Examination of significant hail events: expand the project across the Northeast U.S.

Team lead: Tom Wasula (ALY)

Limited work has been done on this project since 1 June. The 2" and larger hail database was updated through 31 August 31. No new 2" hail reports occurred in the ALY WFO in the 2021 warm season. The ALY WFO climatology continues to have a total of 65 significant hail reports (2" or greater in diameter hail stones) from 1950 to 31 August 2021. There were two additional significant hail reports 1 April to 31 August 2021 in NY: one was in Lisle, Broome County (WFO BGM) on 17 July and the other in Lewiston Heights, Niagara County (WFO BUF) 20 July. Mike Main, WFO ALY meteorologist, will assist in the analysis and the study when he has time. Mike started as the NWS at Albany in November 2020.

Tom will submit an abstract for the 24–28 October 2022 AMS Severe Local Storms Conference in Santa Fe, NM.

7. ***The role of the strength of large-scale low-level forcing on severe weather event magnitudes***
Team leads: Neil Stuart (ALY) and Joe Cebulko (National Water Center)

This project has been completed.

8. ***Use of collapsing specific differential phase columns to predict significant severe thunderstorm wind damage across the Northeast United States***
Team lead: Joe Cebulko (National Water Center)

Joe Cebulko has taken a position with the NWS Water Center and, as a result, this project will not be completed.

6. CSTAR PROJECT RESEARCH IN NWS AFDs

Monday 7 June 2021

CSTAR research on flash flooding was cited in the short-term section of the NWS ALY AFD.

FXUS61 KALY 071950
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
350 PM EDT Mon Jun 7 2021

.SHORT TERM /6 AM TUESDAY MORNING THROUGH WEDNESDAY NIGHT/...
Main concern on Tuesday is potential for slow moving thunderstorms producing torrential rainfall resulting in possible flash flooding. Coverage of showers and storms will be much greater on Tuesday due to increasing ascent from multiple short-wave disturbances moving through and flattening the upper ridge. Moisture will be abundant and anomalously high, with PWAT anomalies of +2 to +3 STDEV from the NAEFS ensemble which is impressively high for early June. Sufficient instability should exist with SBCAPE of 500-1000 J/Kg (NAM looks overdone showing much higher values). Deep layer shear will be weak < 20 kt, with also weak W-SW flow < 20 kt up to 500 mb favorable for slow moving storms. Efficient warm rain processes expected with warm cloud depths of 11-13 kft. Will continue to mention risk of flash flooding in the HWO. **Flash flooding should not be widespread enough to warrant issuance of a watch though, due to a few mitigating factors to more widespread coverage: lack of a strong closed low positioned to our west and lack of significant S-SE flow off the Atlantic (from CSTAR III**

flash flood research). Still, any areas that see slow-moving persistent convection will need to be monitored for possible flash flooding. Temperatures will continue to be well above normal with humid conditions (dewpoints in the 65-70 range), but added cloud cover should limit heat index values to < 95 degrees.

SHORT TERM...JPV

Thursday 10 June 2021

CSTAR research on warm-season cutoff cyclones was cited in the long-term section of the NWS ALY AFD.

FXUS61 KALY 101947
AFDALY

AREA FORECAST DISCUSSION
National Weather Service Albany NY
347 PM EDT Thu Jun 10 2021

.LONG TERM /SUNDAY THROUGH THURSDAY/...
By Tuesday into Thursday, a large closed off upper-level low will be dropping out of southern Canada towards the Northeast. **These types of warm-season closed lows have been studied during CSTAR work between NWS Albany and UAlbany and are capable of producing heavy precipitation, flash flooding and severe thunderstorms across our area.** There is still a great deal of model differences regarding the track/timing of this feature, so it`s still too far out to say if our area will see any of these issues during next week. However, it will need to be watched closely, as periods of showers and thunderstorms ahead of the approaching upper-level low will certainly be possible. For now, will go with CHC pops during much of next week, with the highest chances during the diurnally-favored afternoon and evening hours. In addition, temps will be trending towards below normal thanks to the low heights and cool temp aloft, with highs only reaching the 60s to low 70s across the area for the middle of the week.

LONG TERM...Frugis

Monday 22 November 2021

CSTAR research on the inland extent of lake-effect snow bands was cited in the short-term section of the NWS ALY AFD.

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AREA FORECAST DISCUSSION
National Weather Service Albany NY
117 PM EST Mon Nov 22 2021

.NEAR TERM /THROUGH TONIGHT/...
Strong cold advection is already initiating lake effect processes with broken bands pushing into the western ADKs with minimal accumulation noted on NYSM cams so far. Delta-T values increase to greater than 20C tonight as 850 mb temps fall below -10C. Multi-lake connection should also briefly become established from Superior/Huron, and inversion heights rise to 3km per the NAM sounding at UCA. **Winds in the 0-3 km layer increase with directional shear rather low. All of these factors should favor decent inland extend of lake effect snow per CSTAR research, except that the instability may be a bit on the high side.** Local inland extent program indicates potential for 150-mile inland extent, so have slight chance PoPs extending to the Capital District. Major limiting factor for inland extent is the rather quick shift of the low-level winds from westerly to northwesterly, so do not expect any particular location to receive too much snow. Generally looking at 1-3" for portions of the southwestern ADKs, with an inch or less over the western Mohawk Valley this evening into early tonight. After 06Z, the LES activity is forecast to retract and shift mainly SW of the forecast area. Elsewhere, partly cloudy to mostly clear skies are expected. Lows range from the upper teens to upper 20s.

NEAR TERM...Thompson